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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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EXAMINER

CAZAN, LIVIUS RADU

ART UNIT	PAPER NUMBER
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3729

DATE MAILED: 03/06/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 10/692,029	Applicant(s) SHAO ET AL.	
	Examiner Livius R. Cazan	Art Unit 3729	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 19 February 2004.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-56 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-56 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 23 October 2003 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
 Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
 Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date <u>1/29/04</u> . | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Claim Rejections - 35 USC § 112

1. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

2. Claims 1-56 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the enablement requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention. In particular, Applicant claims to be making a capacitor (page 3, first paragraph; page 5; page 6, paragraphs 1-3). However, as can be seen in Figs. 1 and 2, the circular metal portions 12' and 12" respectively, are continuous, and therefore constitute a single electrode. A capacitor requires two metal electrodes separated by a dielectric. Applicant gives no indication that structures 32' and 32" are a second electrode of the capacitor. In fact, the opposite is suggested (page 5, paragraphs 2 and 3, Ins. 5 and 6 of the respective paragraphs; page 7, last paragraph and page 8 first paragraph). As disclosed in the specification, Applicant is therefore not making a capacitor, since only one electrode is present.

3. The following informalities are also noted within the specification, and must be corrected:

The use of the trademarks CORAL and BLACK DIAMOND has been noted in this application. It should be capitalized wherever it appears and be accompanied by the generic terminology.

Although the use of trademarks is permissible in patent applications, the proprietary nature of the marks should be respected and every effort made to prevent their use in any manner which might adversely affect their validity as trademarks.

Both the specification as a whole and each individual section (i.e. written description, drawings, claims) are numbered. For clarity and so as to avoid confusion, only the numbering of the specification as a whole should be kept.

On page 10, second paragraph, line 5, "about300 to" should read --about 300 to--

Claim Rejections - 35 USC § 102

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

4. Claims 1-3, 5, 7, 9-13, 15-17, 22, 23, 25, 27, 29-31, 33-35, 40, 42, 44-48, and 50-52 are rejected under 35 U.S.C. 102(e) as being anticipated by Ng et al.

The applied reference has a common inventor and common assignee with the instant application. Based upon the earlier effective U.S. filing date of the reference, it constitutes prior art under 35 U.S.C. 102(e). This rejection under 35 U.S.C. 102(e) might be overcome either by a showing under 37 CFR 1.132 that any invention disclosed but not claimed in the reference was derived from the inventor of this

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application and is thus not the invention "by another," or by an appropriate showing under 37 CFR 1.131.

a. Regarding claims 1-3, 5, 7, 9-11, 22, 23, 25, 27, 29, 40, 42, and 44-46, Ng et al. disclose the same invention as the applicant, including:

- providing a substrate/semiconductor wafer (semiconductor substrate 10, any figure; see col. 2, Ins. 50-60;) having a lower low-k dielectric layer formed thereover (intermediate dielectric layers 20 and 40; see col. 2, Ins 60-67 and col. 3, Ins. 20-35); the lower low-k dielectric layer having a dielectric constant of less than about 3.0 and a thickness of from about 2000 to 50,000Å. Ng et al. disclose the use of TEOS, CORAL, and BLACK DIAMOND as a low-k dielectric (col. 2, Ins. 60-67), the same material claimed by the applicant in claims 5, 25, and 42, and therefore the dielectric disclosed by Ng et al. inherently has all the properties claimed by the applicant, including a dielectric constant of less than about 3.0. The thickness of the dielectric layer is specified to be between a few hundred and a few thousand Angstroms (col. 3, Ins 30-35). It is deemed that at least a portion of this range includes values over 2000Å, since the term "a few thousand" clearly means at least two thousand. Also see US6426249 for extrinsic evidence that using a first dielectric layer having a dielectric constant of less than 3 (col. 3, Ins. 10-30) and having a thickness between 2000 and 50000Å (5000 to 12000Å, col. 3, Ins. 10-30) is known in the art.

See MPEP § 2131.03 for case law pertaining to rejections based on the anticipation of ranges under 35 U.S.C. 102 and 35 U.S.C. 102/ 103.

- forming copper vertical electrode plates within the lower low-k dielectric layer (metal plates 52 in Fig. 6 for example) such that adjacent metal vertical electrode plates have lower low-k dielectric layer portions therebetween (copper plates 52 in Fig. 6 have low-k dielectric material between them);
- replacing the lower low-k dielectric layer portions between the adjacent metal vertical electrode plates with high-k dielectric material trench portions; the high-k dielectric material trench portions having a dielectric constant of greater than about 3.0 and are comprised of a non-conductive oxidized refractory metal. In Fig. 9, the low-k dielectric between plates 52 has been replaced with high-k dielectric material 70 having a dielectric constant of more than 7 (col. 4, Ins. 5-15). The dielectric material can be silicon nitride (SiN) or tantalum oxide (TaO) for example, tantalum being a refractory metal.

Note: Ng et al. first form an interconnect in dielectric 20, to demonstrate the process, and then form a capacitor in a second dielectric 40, but acknowledge that the capacitor could have been formed in dielectric 20 (col. 3, Ins. 15-30).

- b. Regarding claims 12, 13, 30, 31, 47, and 48, Ng et al. disclose the same invention as the applicant, including a step of lining copper vertical electrode

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plates with respective metal barrier layers (50 in Fig. 6 for example). See col. 3, Ins. 40-60.

c. Regarding claims 15-17, 33-35, and 50-52, Ng et al. disclose the same invention as the applicant, including:

- forming an upper low-k dielectric material layer (80 in Fig. 10 for example) over the copper vertical electrode plates (52 in Fig. 10) to a thickness of from about 2000 to about 50,000Å (see discussion in part **a** above regarding insulator thickness); the upper low-k dielectric material layer having a dielectric constant of less than about 3.0 (as previously discussed; see col. 4, Ins. 10-30);
- forming respective lined via structures within the upper low-k dielectric material layer in electrical communication with the respective metal vertical electrode plates (see Fig. 12; see col. 4, Ins 15-40); the via structures being comprised of copper or tungsten (copper in this case; see col. 4, Ins. 30-40)

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

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6. Claims 4, 18-21, 24, 36-39, 41, and 53-56 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ng et al. in view of Tu et al. (US6271084).

a. Regarding claims 4, 24, and 41, Ng et al. disclose the same invention as the applicant, except for a low-k dielectric layer having a thickness of from about 5000 to 10,000 Å.

Tu et al. teach a method of forming an MIM capacitor having a lower low-k dielectric layer (6 in Fig. 1 for example) having a thickness of between 5000 and 12,000Å (col. 4, Ins. 50 to 60).

The range taught by Tu et al. overlaps with the range of 5000 to 10,000Å claimed by the applicant.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to form a lower low-k dielectric layer of a thickness as claimed by the applicant, in view of the teachings of Tu et al., in order to obtain a capacitor having a dielectric depth satisfying the design requirements of the capacitor. Furthermore, it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum workable ranges involves only routine skill in the art (*In re Aller*, 105 USPQ 233), and that discovering an optimum value of a result effective variable involves only routine skill in the art (*In re Boesch*, 617 F.2d 272, 205 USPQ (CCPA 1980)).

Also see MPEP § 2131.03 for case law pertaining to rejections based on the anticipation of ranges under 35 U.S.C. 102 and 35 U.S.C. 102/ 103 and MPEP § 2144.05 for obviousness of ranges.

b. Regarding claims 18, 36, and 53, see the pertinent discussions in part **4d** above regarding the forming of an upper low-k dielectric material and forming of via structures, and **6a** above regarding an insulator thickness between 5000 and 10,000Å.

c. Regarding claims 19-21, 37-39, and 54-56, Ng et al. disclose the same invention as the applicant, including:

- forming an upper low-k dielectric material layer; the upper low-k dielectric material layer having a dielectric constant of less than about 3.0;
- forming respective via structures within the upper low-k dielectric material layer in electrical communication with the respective metal vertical electrode plates.

See pertinent discussion in the discussion of claims 15-17, 33-35, and 50-52 in part **4d** above.

Ng et al do not disclose forming an etch stop layer as follows:

- forming an etch stop layer *over the copper vertical electrode plates* to a thickness of from about 100 to 1000Å, in particular from 300 to 600Å; the etch stop layer being formed of SiN or Si_xO_yN_z, in particular of SiN.

- forming an upper low-k dielectric material layer *over the etch stop layer*, the upper low-k dielectric material layer having a dielectric constant of less than about 3.0;
- forming respective lined via structures *within the etch stop layer* and the upper low-k dielectric material layer in electrical communication with the respective copper vertical electrode plates

Tu et al. teach the use of an etch stop layer of either silicon oxynitride (300 to 600Å) or silicon nitride (800 to 1200Å) (see col. 3, Ins. 10-45) to prevent an etching process from etching into the material below the stop layer.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to provide an etch stop layer between the metal vertical electrode plates and the upper low-k dielectric, in view of the teachings of Ta et al., in order to allow better control over the etching process.

Furthermore, the thickness of the etch stop layer can be selected depending on the requirements of the particular process, and it is known to do so. Therefore it would have been obvious to one having ordinary skill in the art at the time the invention was made to provide an etch stop layer of appropriate thickness (such as 300 to 600Å for example) since it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum workable ranges involves only routine skill in the art (*In re Aller*, 105 USPQ 233), and that discovering an optimum value of a result effective variable involves only routine skill in the art (*In re Boesch*, 617 F.2d 272, 205 USPQ

(CCPA 1980)). Also note that the ranges taught by Tu et al. are in general agreement with those disclosed by the applicant. See MPEP § 2131.03 for case law pertaining to rejections based on the anticipation of ranges under 35 U.S.C. 102 and 35 U.S.C. 102/ 103 and MPEP § 2144.05 for obviousness of ranges.

7. Claims 6, 26, and 43 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ng et al. in view of Wetzel et al. (US5920790).

Ng et al. disclose the same invention as the applicant, except for a lower low-k dielectric layer comprised of an organic material.

Wetzel et al. teach the use of such low-k dielectric materials in the formation of semiconductor devices (col. 4, lns. 1-15).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to use an organic low-k dielectric material instead of an inorganic low-k material (such as those claimed in claim 7 for example) since it has been held to be within the general skill of a worker in the art to select a known material on the basis of its suitability for the intended use as a matter of obvious design choice. *In re Leshin*, 125 USPQ 416.

8. Claims 8 and 28 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ng et al. in view of Kola et al. (US5936831).

Ng et al disclose the same invention as the applicant, except for high-k dielectric material trench portions being comprised of a low leakage and high breakdown material.

Kola et al. teach the use of Ta₂O₅N_y as a high-k dielectric material in capacitors (see abstract; see claim 1).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to use a high-k, low leakage, high breakdown material, such as that taught by Kola et al., since it has been held to be within the general skill of a worker in the art to select a known material on the basis of its suitability for the intended use as a matter of obvious design choice. *In re Leshin*, 125 USPQ 416.

9. Claims 14, 32, and 49 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ng et al. in view of Ma et al. (US6472721).

Ng et al disclose the same invention as the applicant, except for lining copper vertical electrode plates with respective metal barrier layers comprised of Ta/TaN.

Ma et al. teach lining via/trench openings (to be later filled with copper) with Ta/TaN (see claim 5).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to use a Ta/TaN lining as taught by Ma et al., instead of another material, such as Ta or TaN alone, since it has been held to be within the general skill of a worker in the art to select a known material on the basis of its suitability for the intended use as a matter of obvious design choice. *In re Leshin*, 125 USPQ 416.

Conclusion

10. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Livius R. Cazan whose telephone number is (571) 272-8032. The examiner can normally be reached on 7:30AM-4:00PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Peter Vo can be reached on (571)272-4690. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

LRC 03/02/2006



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